PhD scholarship application in geomechanics

Modelling the impact of rock fractures, alteration, and mineral composition on rock properties in deep geothermal context

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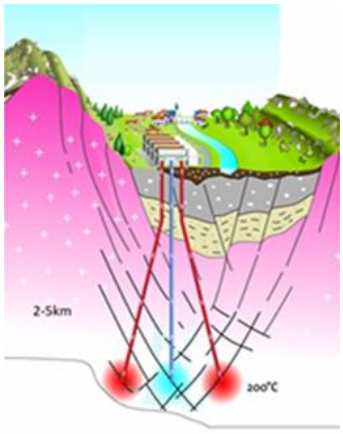
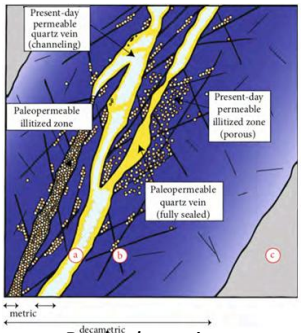
Project description

Context:

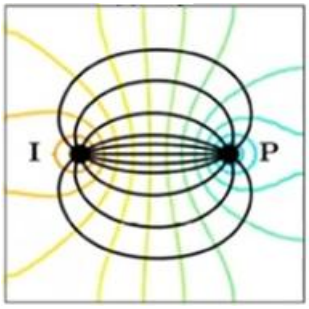
The propose study addresses socio-economic and environmental challenges of using soil and subsoil resources, particularly in the context of the energy transition. Nowadays, a key focus is on **deep geothermal energy**, which relies on the ability of underground rock formations to store and transmit thermal fluids effectively. **High-enthalpy geothermal systems** depend on the **quality of reservoir rocks**, which is governed by, for instance, their **porosity, fracture structure, permeability, and fluid circulation**. All of which are influenced by the rock structure and **mineral composition**, as well as its possible evolution. This is particularly the case for rock-fluid interaction in porous or fractured rocks, possibly leading to rock damage, alteration, and porosity/mineral variation (e.g. dissolution, precipitation, etc.). For instance, the precipitation of minerals (e.g. clay) tends to reduce hydraulic permeability, affecting fluid circulation and the efficiency of geothermal systems.



High-enthalpy geothermal systems (BRGM image)



Rock alteration, mineral precipitation
(Glass et al., 2019)



Geothermal doublet, fluid flow/pressure
(McLean and Espinoza, 2022)

Objectives and method:

The main objectives of the research are to:
- Integrate fracture structure and mineral composition into the assessment of **hydromechanical rock properties**.
- **Model the evolution** of mineral content due to **alteration processes**.
- Predict the impact on **reservoir behaviour and geothermal production at larger scales**.

To achieve this, the study will develop a **theoretical and numerical multiphysical (TH(MC)) model** that links microstructural properties to macroscopic rock behaviour. This geomechanics and rock mechanics work will be realised using finite element modelling approaches (e.g. Comsol MultiPhysics).

Candidate profile

Candidates can apply for a PhD scholarship at University of Lyon (ENTPE engineering school, LTDS laboratory, Lyon, France). Applications are welcome from students graduated (Msc.) in the fields of civil, mechanical, materials, and geotechnical engineering, or geosciences. Basic knowledge in mechanics of porous/fractured media, constitutive modelling of geomaterials, multiphysics, and interest for numerical methods in geomechanics is required. The 3-year project will give the applicant opportunities to develop various technical skills (advanced numerical methods, poromechanics, elastoplasticity, damage approach, etc.) and to integrate a dynamic geomechanics network having a large experience in numerical modelling. The successful applicant will use and improve coupled non-linear finite element models, based on experimental data. The ability to communicate orally and write in English is required and international mobility is encouraged.

Application

Applications should be submitted by Dec 2026 by emailing a CV, motivations, academic grades (detail of marks), scientific/academic references, recommendation letter, and passport scan to benoit.pardoen@entpe.fr. Any additional document relevant for the application can also be transmitted, especially for international applications.